# WELCOME TO
# NASA APPLIED REMOTE SENSING TRAINING (ARSET)
# WEBINAR SERIES

## INTRODUCTION TO REMOTE SENSING FOR CONSERVATION MANAGEMENT

**COURSE DATES: EVERY TUESDAY, MAY 5 – JUNE 2**
**TIME: 12:00 – 1:00 PM EDT**
**OR**
**10:00 – 11:00 PM EDT**

# Course Structure

- One lecture per week – every Tuesday May 5 to June 2
  - 12:00 – 1:00 PM EDT (Session 1)
  - 10:00 – 11:00 PM EDT (Session 2)

- Webinar recordings, PowerPoint presentations, and homework assignments can be found after each session at: https://arset.gsfc.nasa.gov/ecoforecasting/webinars/introduction-remote-sensing-conservation-management

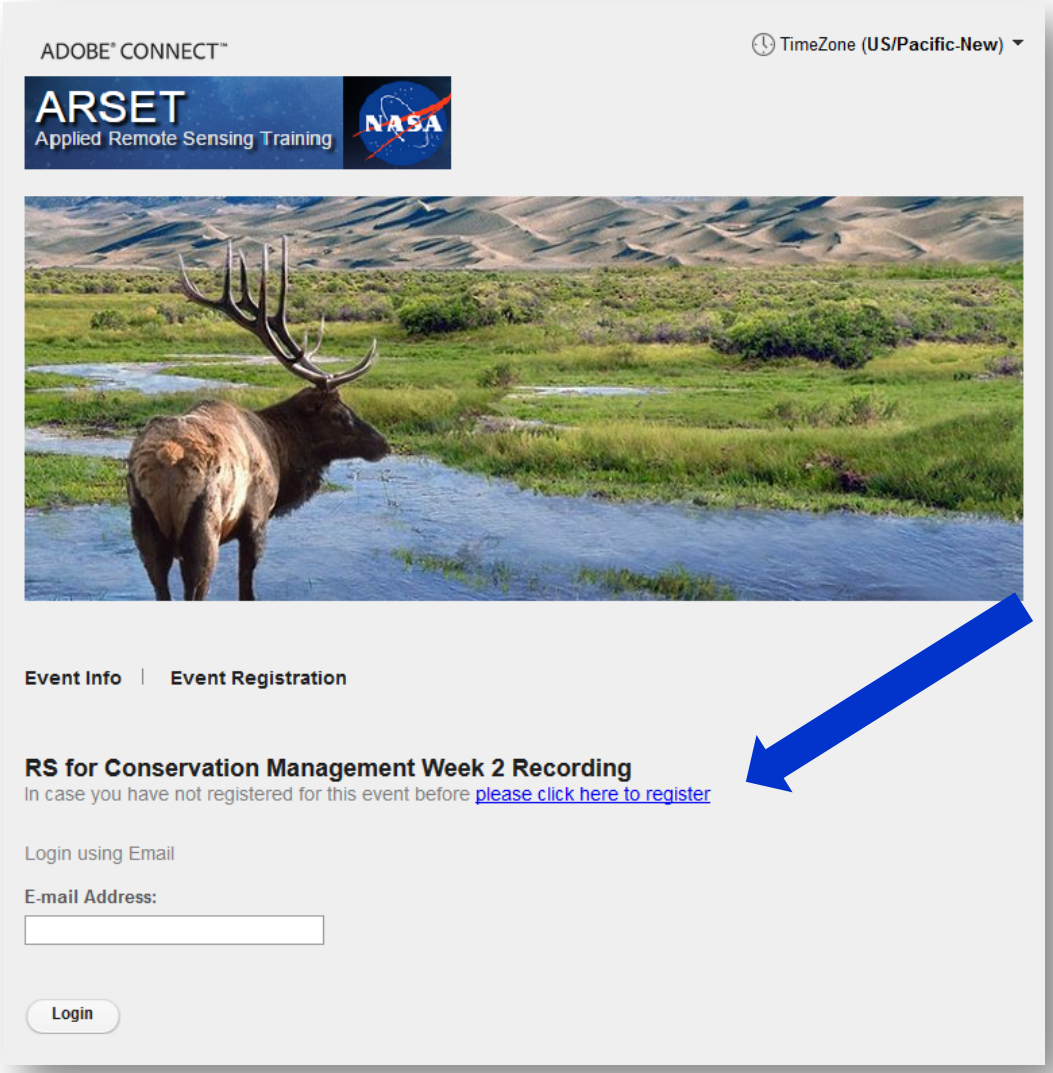
- Certificate of Completion
  - Attend 4 out of 5 webinars
  - Assignment 1 and 2 – access from the ARSET Conservation Management webinar website (above)
  - You will receive certificates approximately 1 month after the completion of the course from: marines.martins@ssaihq.com

- Q/A: 15 minutes following each lecture and/or by email (cynthia.l.schmidt@nasa.gov)

# ARSET Conservation Management


https://arset.gsfc.nasa.gov/ecoforecasting/webinars/introduction-remote-sensing-conservation-management

# Accessing the Recordings




You must register to access the recordings!
This is different from your webinar registration.

# Your Course Instructors

- Cindy Schmidt (ARSET): cynthia.l.schmidt@nasa.gov
- Amber Kuss (ARSET): amberjean.m.kuss@nasa.gov
- Guest Speakers:
  - Walter Jetz – Yale University (week 3)
  - Jeff Cavner –University of Kansas (week 4)
  - Karyn Tabor – Conservation International (week 5)

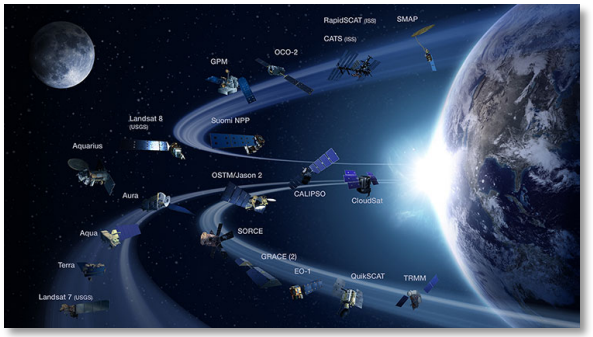
General inquiries about ARSET: Ana Prados (ARSET)
aprados@umbc.edu

# Course Outline

## Week 1

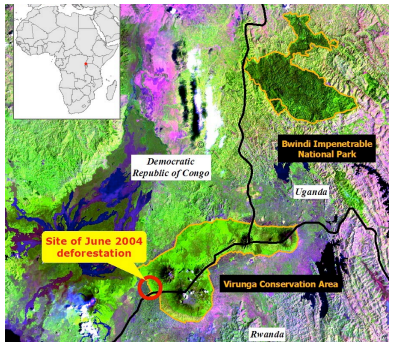
Overview of satellite remote sensing

## Week 2



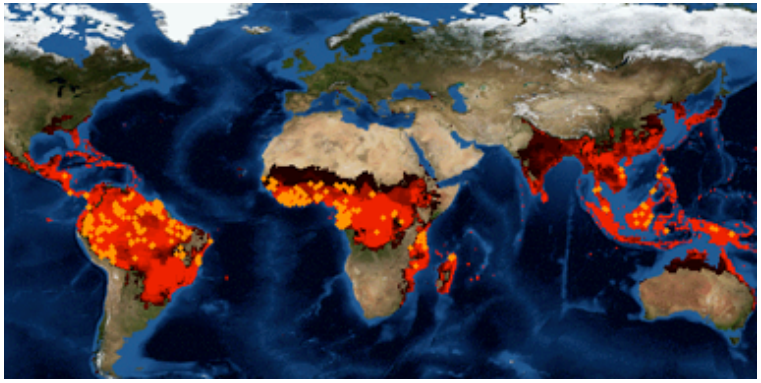

Platforms and sensors for conservation

## Week 3



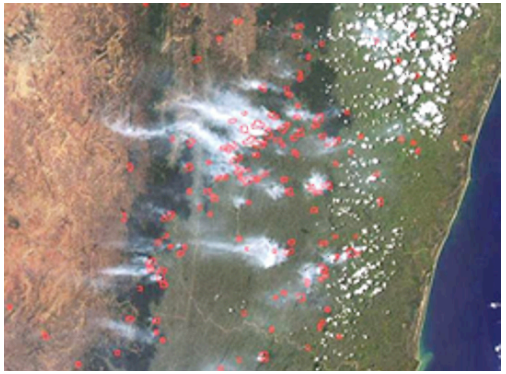

Habitat monitoring

## Week 4



Animal movement

## Week 5



Near-real time data

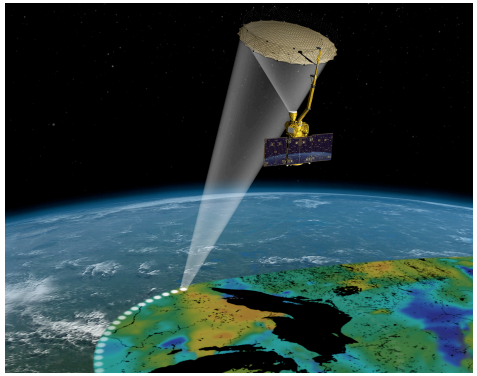
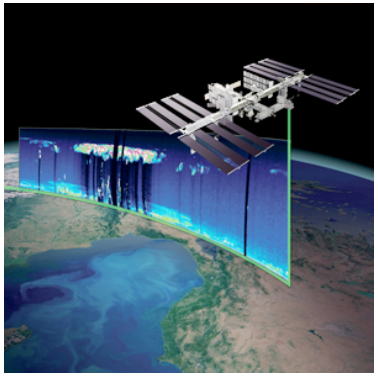
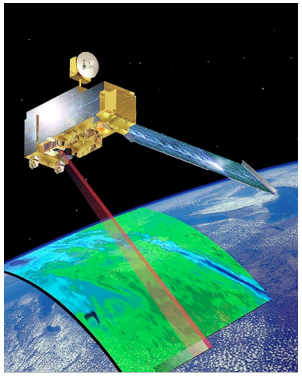
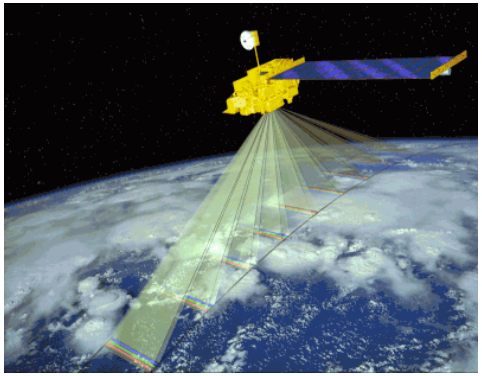
# Agenda: Week 3

- Brief review of last week
- Overview of habitat monitoring
- Overview of land cover mapping
- Accessing land cover products: US and Global
- Uses of land cover products
- Land cover change detection methods
- Change detection visualization tools
- Live demo
  - Map of Life: Dr. Walter Jetz, Yale University

# Review of Week 2

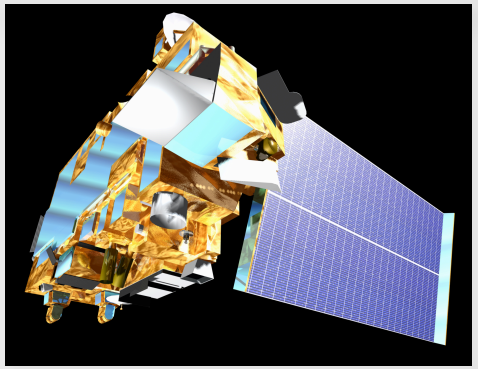
# Levels of Data Processing and Spatial Resolution

- **Level 1 and Level 2** data products have the highest spatial and temporal resolution.
- **Level 3 and 4 products** are derived products with equal or lower spatial and temporal resolution than Level 2 products.

# Land Resources Satellites and Sensors

- **Landsat**
  - Brief Overview (History and Current Missions)
  - Characteristics of Landsat Data
  - Where to Obtain Landsat Images
- **MODIS**
  - Brief Overview
  - Characteristics of MODIS data
  - Where to Obtain MODIS products
- **Live demonstrations**
  - LandsatLook Viewer
  - MRTWeb



# Overview of Habitat Monitoring

# Overview of Habitat Monitoring

- Used to assess the threat and conservation status of species and protected areas
- IUCN Red List key criteria:
  - Habitat extent
  - Fragmentation
  - Rate of Change

Image credit: E. De Merode

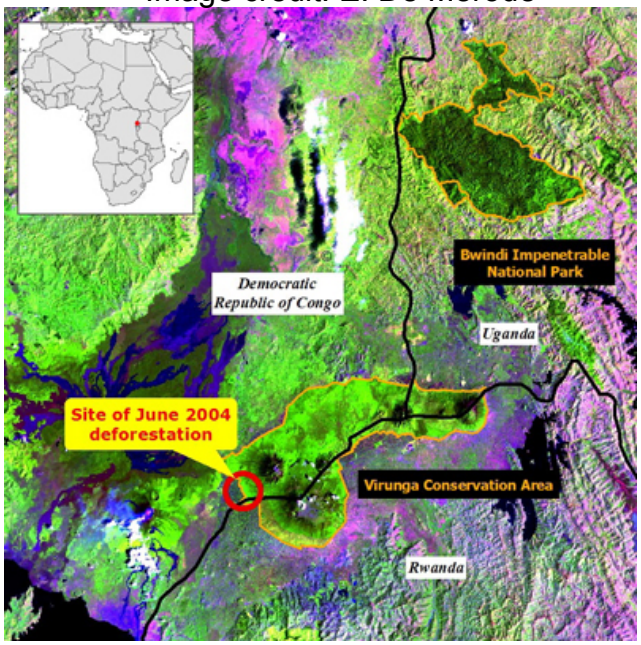


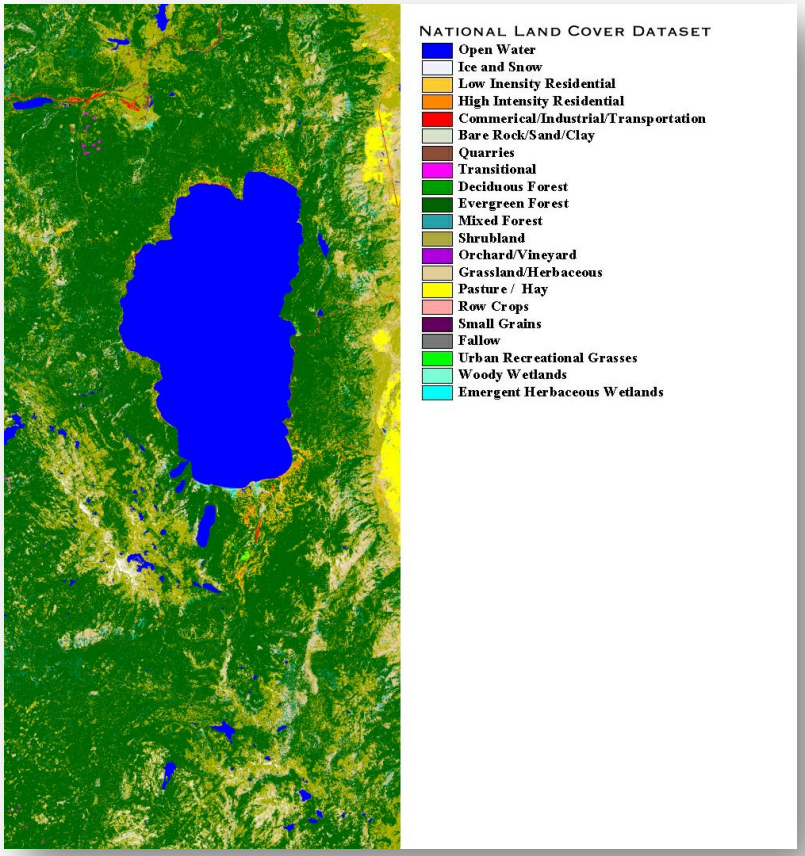

Image credit: Nadine Laporte/Tiffany Lin

*Land changes in the Virunga Conservation Area which provides habitat to approximately 380 mountain gorillas*

*Rapid deforestation occurred in June 2004 in the "Mikeno" section of the park*

# Habitat monitoring: Land Cover Mapping

# Turning Data into Information: Land Cover Maps

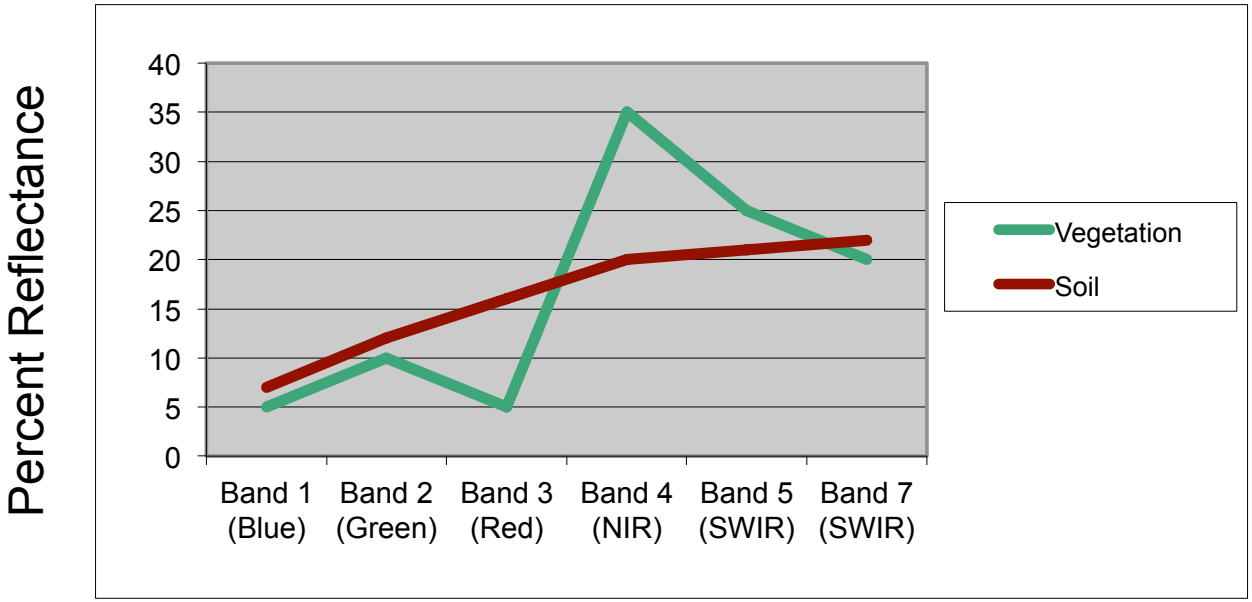



Landsat Image of Lake Tahoe

Landcover map of Lake Tahoe

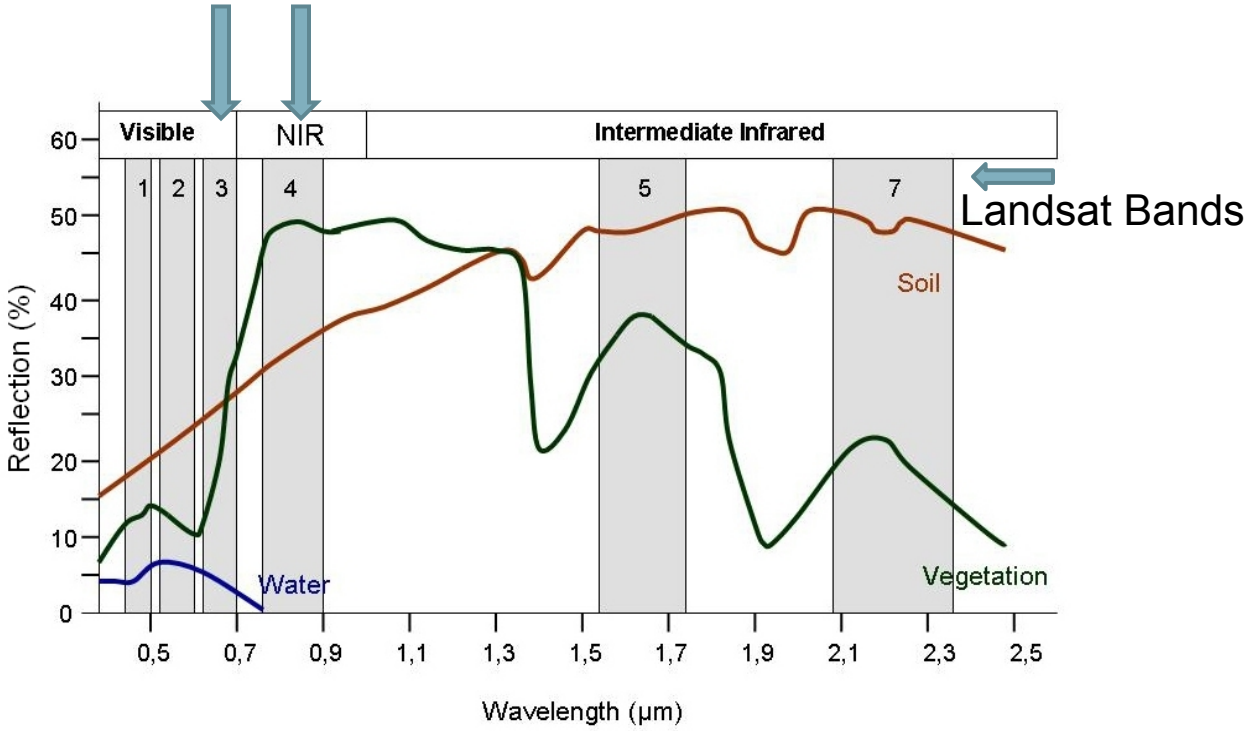
# Land Cover Mapping Basics

Remember that objects on the ground reflect electromagnetic radiation differently

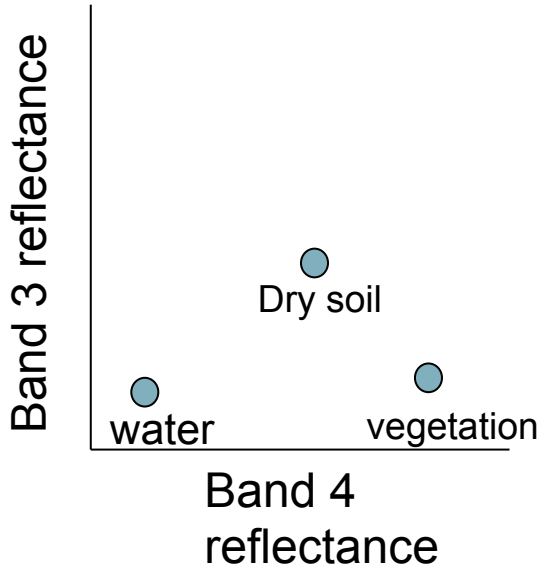



That is called the object's "spectral signature"

# Land Cover Mapping Basics

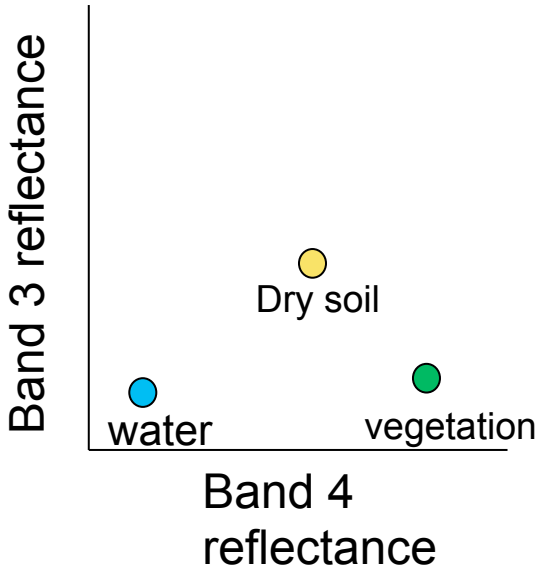


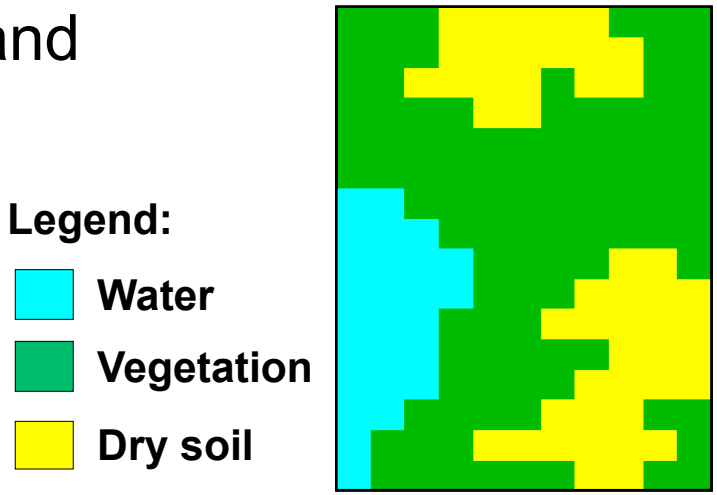

Now we will look at the spectral signatures a little differently by plotting Band 3 (Red) vs. Band 4 (NIR) reflectance values



# Land Cover Mapping Basics

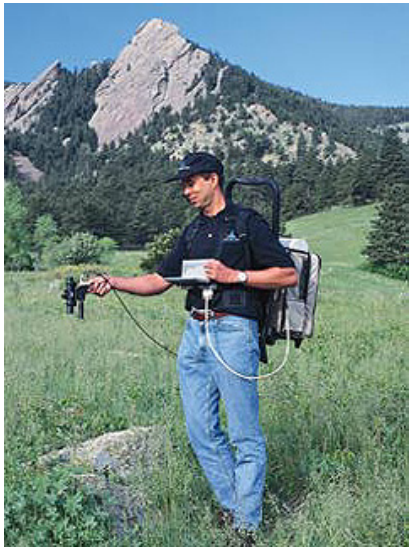
- Using Image Processing software, image classification involves using n number of bands, not just 2.
- You specify the number of land cover classes that are in your study area.
- There are many methods, but two common ones are Supervised and Unsupervised classification



# Land Cover Mapping Basics

- Common question: Can you distinguish between different vegetation types?
- Answer: It depends.
  - Green vegetation is very spectrally similar
  - Possible solutions:
    - Hyperspectral imagers
    - Ancillary information: elevation, slope, aspect
    - Field work (spectroradiometer)

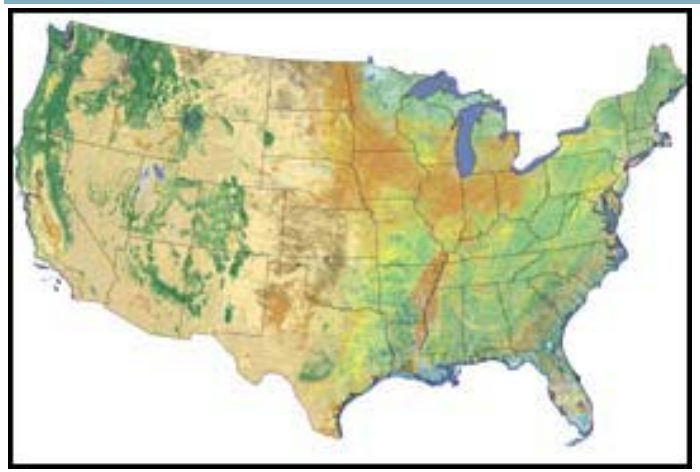


# Land Cover Products

# Landsat Derived Land Cover Products

- **United States**
  - National Land Cover Database (NLCD)
  - GAP Analysis
  - LANDFIRE
- **Global**
  - Global Land Cover Network (FAO)
  - Forest Change Products (Amazon Basin, Central Africa, Paraguay) and Landsat Tree Cover (GLCF)

# National Land Cover Database (NLCD)



**http://www.mrlc.gov/nlcd11_data.php**

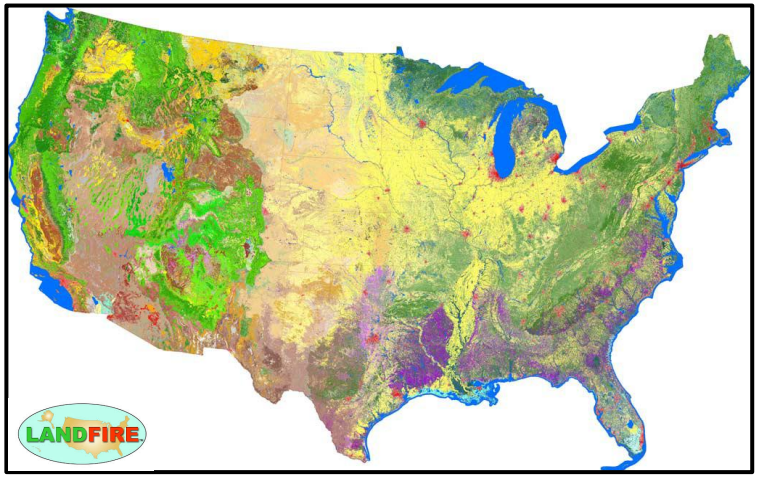
- Supported by the Multi-Resolution Land Characteristic Consortium (MLRC)
- Provides National Land Cover Mapping products at 30m resolution for 1992, 2001, 2006 and 2011.
- 16 class Land Cover classification scheme of the entire U.S. (modified from The Anderson Level 2 Classification System)
- Other NLCD Mapping products include: Land Cover Change, Percent Tree Canopy, and Percent Developed Imperviousness (1992, 2001, 2006)

# National Gap Analysis Program

http://gapanalysis.usgs.gov


- Land cover maps
- Species distribution maps
- Land stewardship/protected areas

# LANDFIRE (Interagency partnership between USFS and USGS)



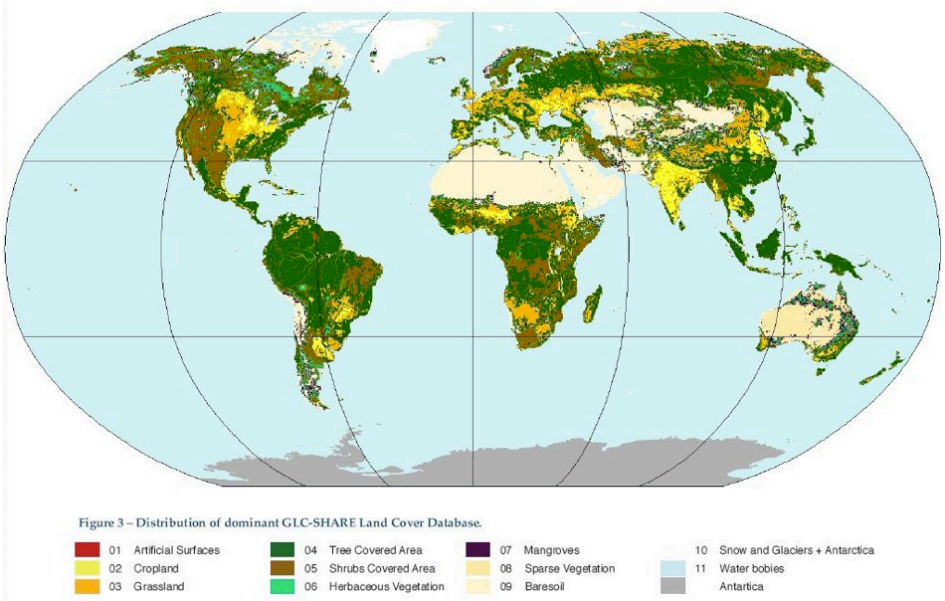

http://www.landfire.gov

**Products: Delivered at 30 m spatial resolution**

- **Vegetation data layers** using Landsat imagery from 1999 - present
  - Current and historic vegetation composition and structure of the entire U.S.
- **Fuel and Fire Regime data layers**
  - Fire behavior and fuel loading models for entire U.S. 1999 -present
- **Disturbance data**
  - Fuel, vegetation, natural, and prescribed disturbance by type and year 1999-present

# FAO Global Land Cover-SHARE (GLC-SHARE)

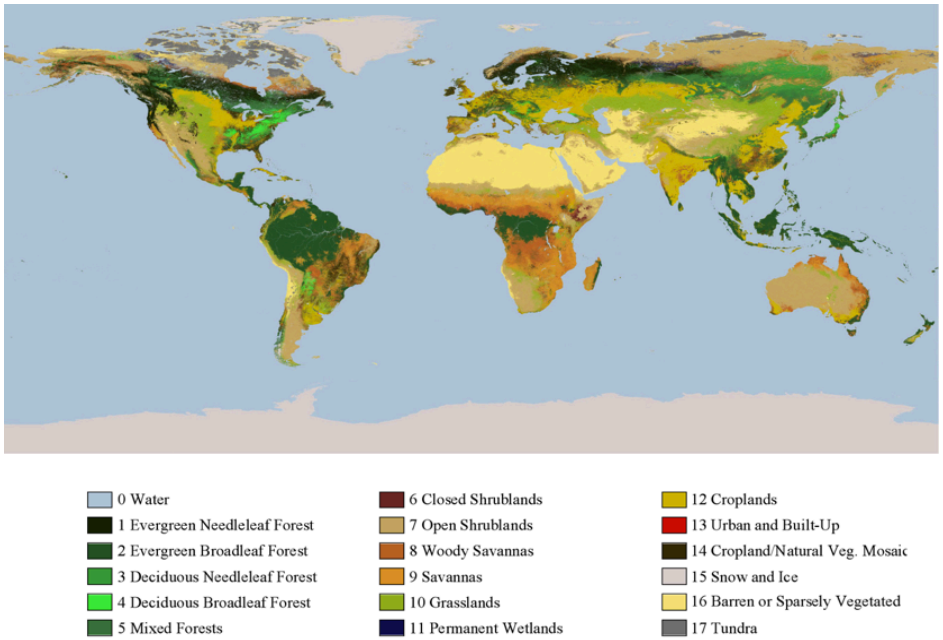
http://www.glcn.org/databases/lc_glcshare_en.jsp




- GLC-SHARE combines “best available” high resolution national, regional and/or subnational land cover databases
- Produced with a resolution of 30 arc-second (~ 1 sq. km.)
- 11 land cover classes
- Beta-release 1.0

# MODIS Land Products: Land Cover (MCD12Q1)

- Yearly 500 meter product
- Primary Land Cover Type Scheme: International Geosphere Biosphere Program (IGBP) global vegetation classification scheme
  - 11 vegetation classes
  - 3 developed classes
  - 3 non-vegetated classes

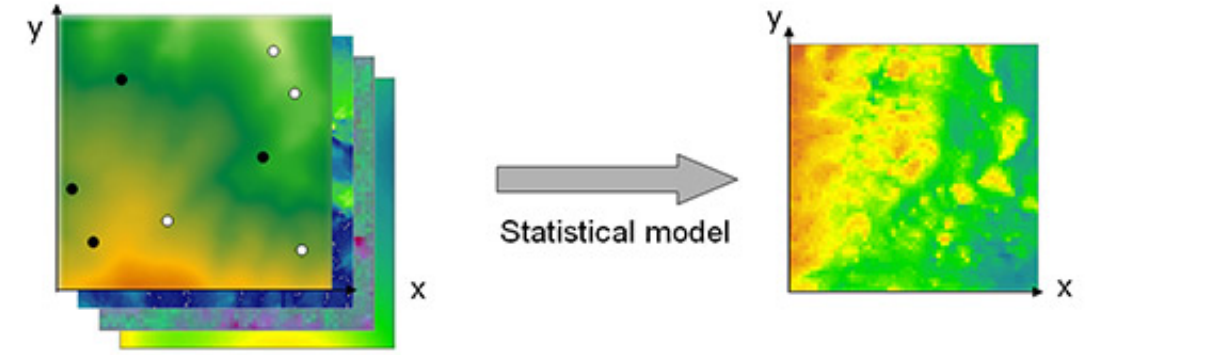



http://reverb.echo.nasa.gov/

# Uses of Land Cover Maps for Habitat Monitoring

# Habitat Suitability/Species Distribution Modeling

Links spatially referenced records of species occurrence with environmental variables




Field records and maps of environment

Map of probability species is present

Example Inputs:

- Vegetation map
- Digital Elevation Model
- Proximity to Water
- Presence and absence of target species

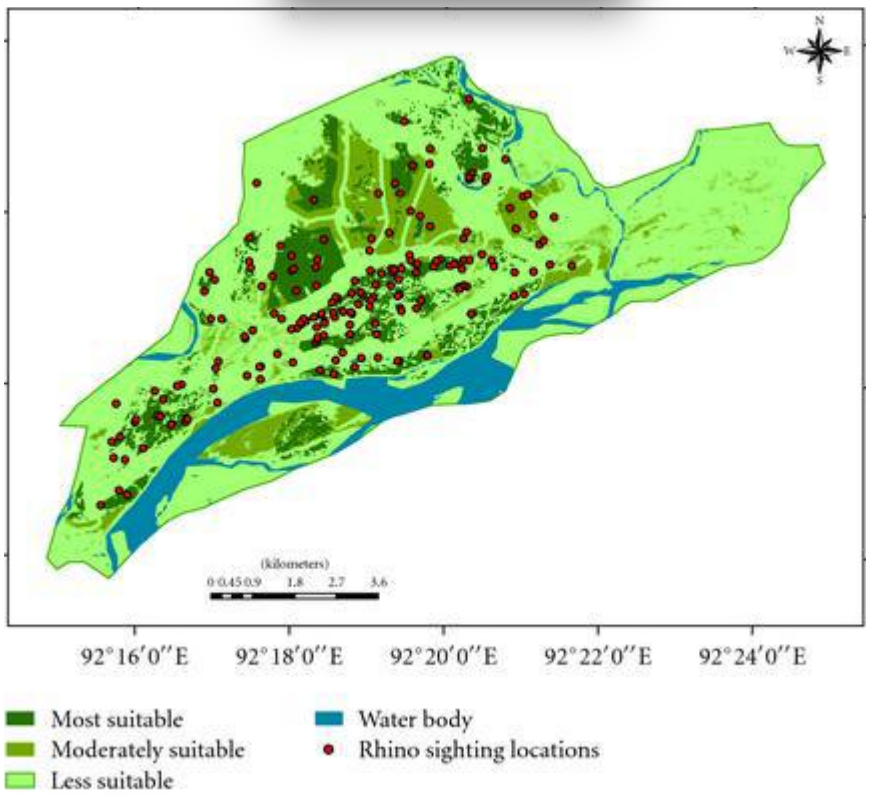
# Habitat Suitability for Rhinoceros

Indian Remote Sensing (IRS) satellite imagery was used to assess the habitat types of Rhinoceros in Orang National Park in India.

In addition to landcover, proximity to water, location of human settlement, elevation and distance to roads were used to develop this habitat suitability map.

Source: Sarma et al., 2011, ISRN Ecology

Credit: www.worldwildlife.org

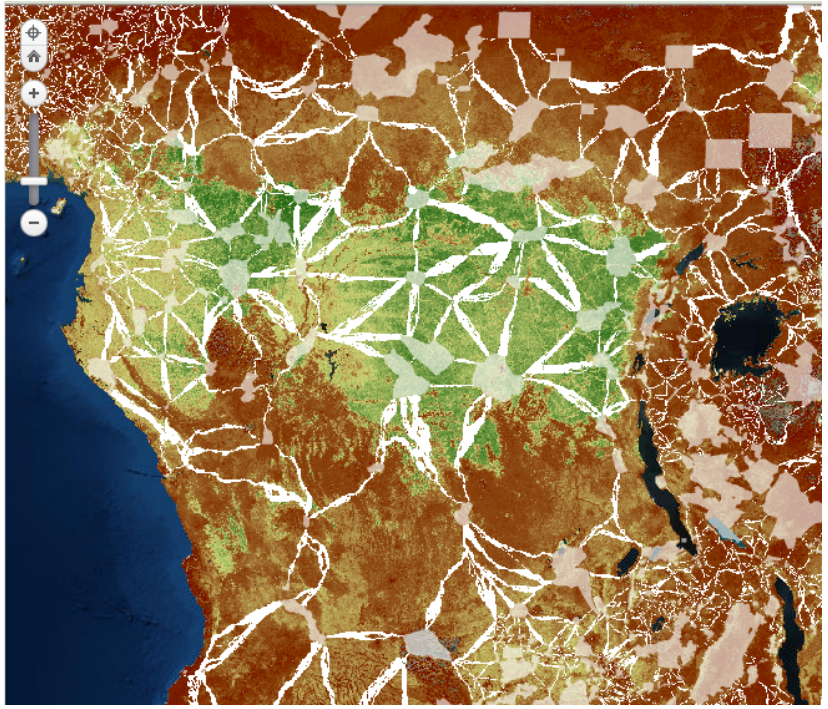


# Identifying Important Landscape Characteristics

- Connectivity and Corridors
  - How are critical habitat areas connected to each other to allow species movement?

Corridors optimizing pathways between protected areas in Central Africa via high vegetation carbon stock areas are mapped in this image. This may help avoid deforestation in these areas.

For more information: http://whrc.org/mapping/pantropical/habitatcorridors/index.html

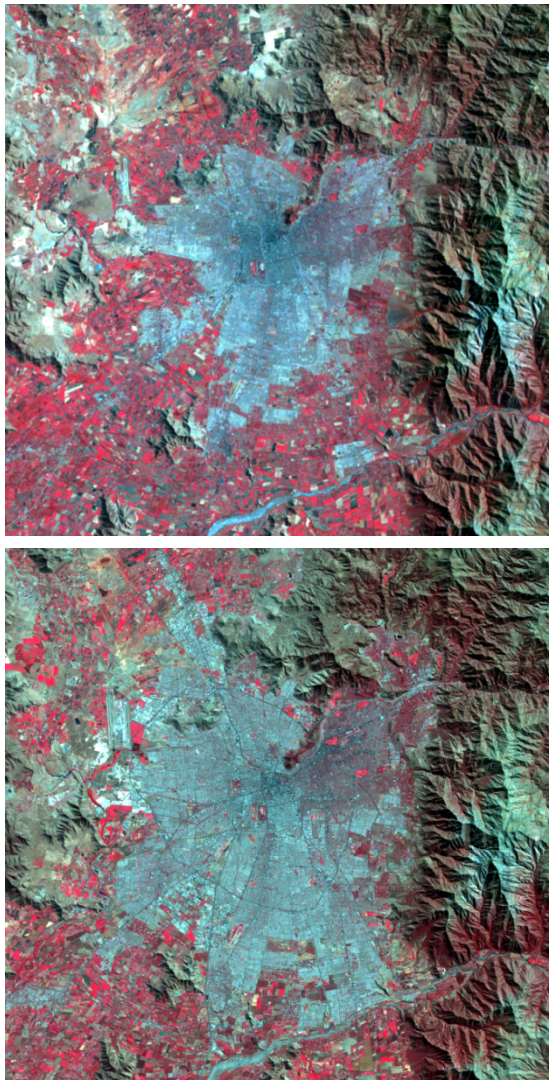


Jantz, P. et al., (2014) Nature Climate Change

# Habitat Monitoring: Detecting Land Cover Change

# What is Change Detection?

- The comparison of information about an area on the earth over two or more points in time.
  - Where and when has change taken place?
  - How much change, and what type of change has occurred?
  - What are the cycles and trends in the change?



*Santiago, Chile urban growth from 1975 to 2013 from Landsat*
*Source: earthshots.usgs.gov*

# Change Detection Applications

- Deforestation (humans) assessment
- Forest disturbance (wildfire, insects or pathogens) assessment
- Vegetation phenology
- Urban growth
- Etc…..



Bark beetle infestation in Colorado between 2005 and 2011

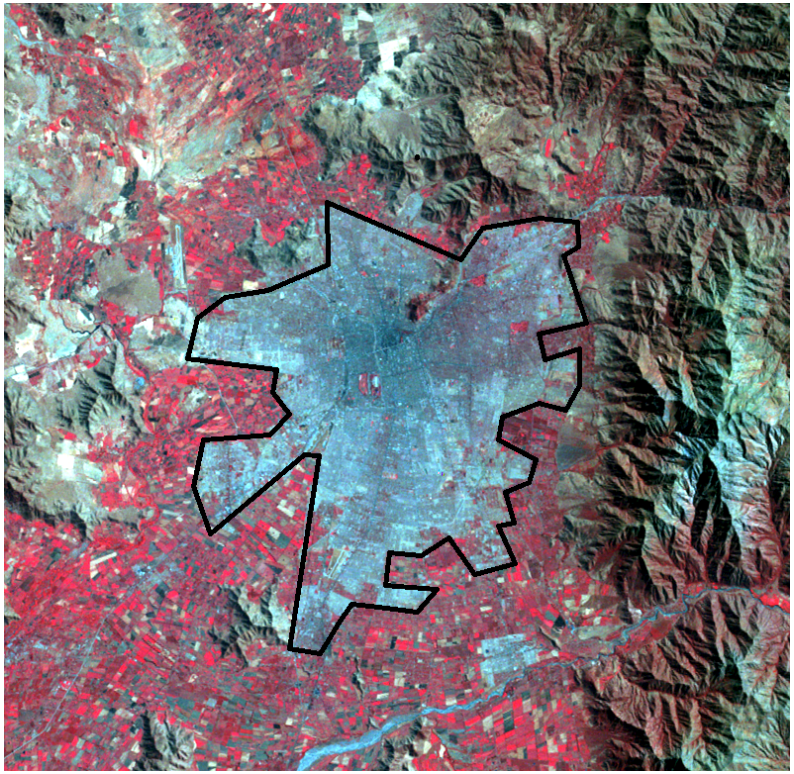
*Source: earthobservatory.nasa.gov*

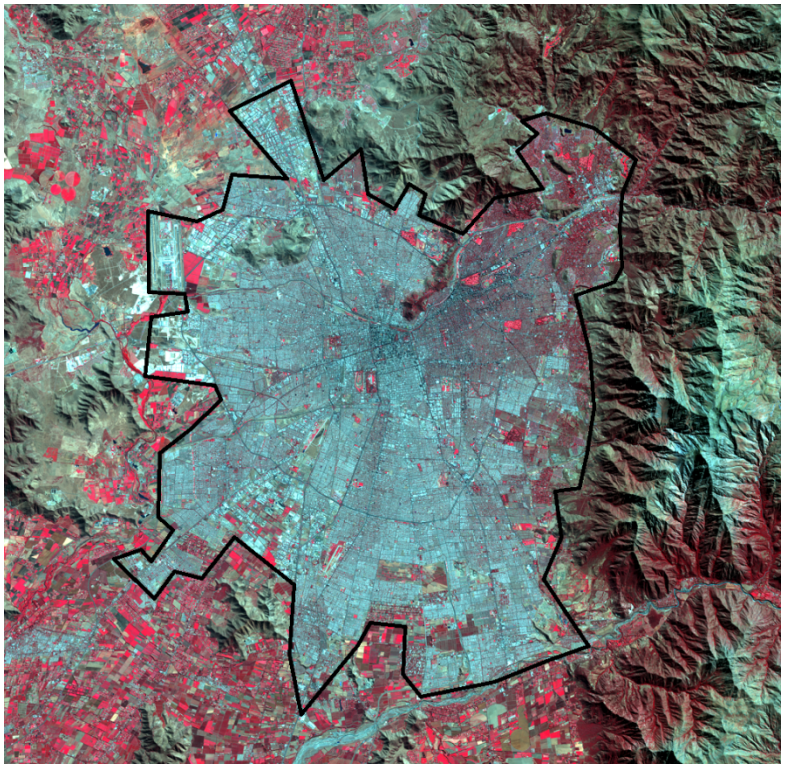
# Change Detection Methods

- Visual analysis
- Classification approaches
- Image Differencing
- New developments: Temporal trajectories

# Change Detection: Visual Analysis

- Heads-up digitizing
- Need GIS or Image Processing software

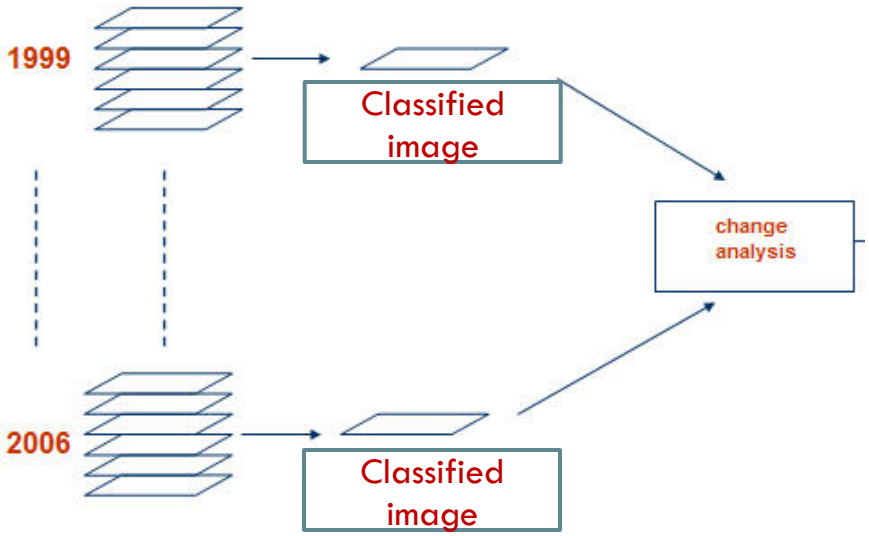




*Santiago, Chile urban growth from 1975 to 2013 from Landsat*
*Source: earthshots.usgs.gov*

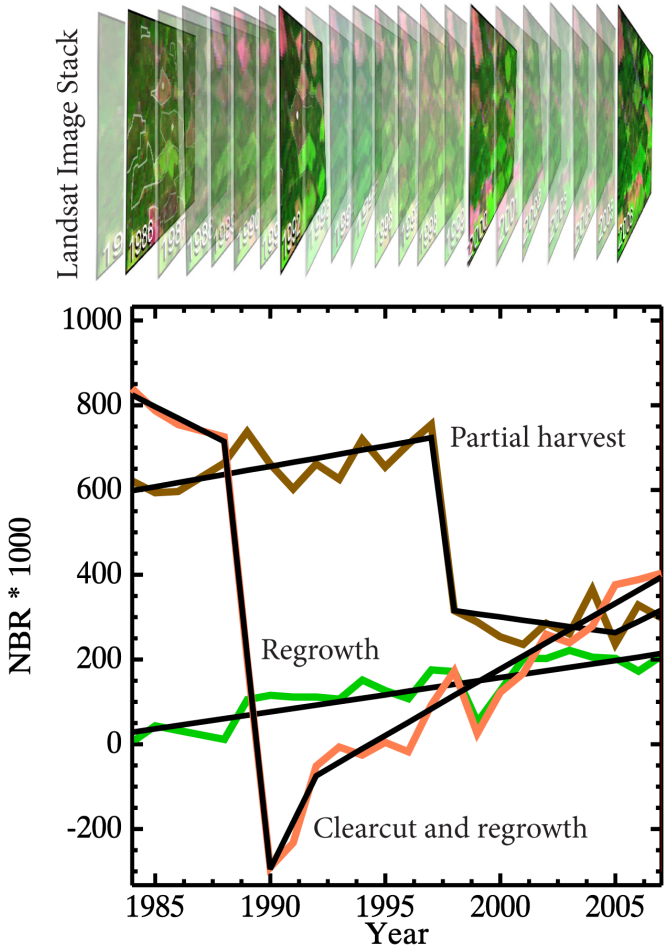
# Change Detection: Traditional Processing Methods

- Two dates of imagery (i.e. 5 to 10 years apart)
  - Image subtraction
  - Image classification
- Need:
  - GIS or image processing software
  - Ability to interpret change
  - Precise registration of images



# Change Detection Methods: Recent Developments

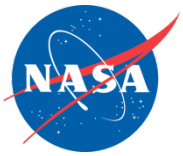
- New methods (such as Landtrendr and Vegetation Change Tracker) take advantage of the entire Landsat archive (1985-current) by using an annual time series to look at changes/trends
- What comes from Landtrendr:
  - Magnitude of change: 1-100% tree cover loss
  - Duration: 1-25 years
  - Year of onset of disturbance




*Kennedy, R., et al. (2010). Detecting trends in forest disturbance and recovery using early Landsat time series: 1. LandTrendr- Temporal segmentation algorithms. Remote sensing of Environment, 114, 2897-2910*

# Where to Obtain and Visualize Change Detection Datasets

# Datasets and Websites Used for Analyzing Change



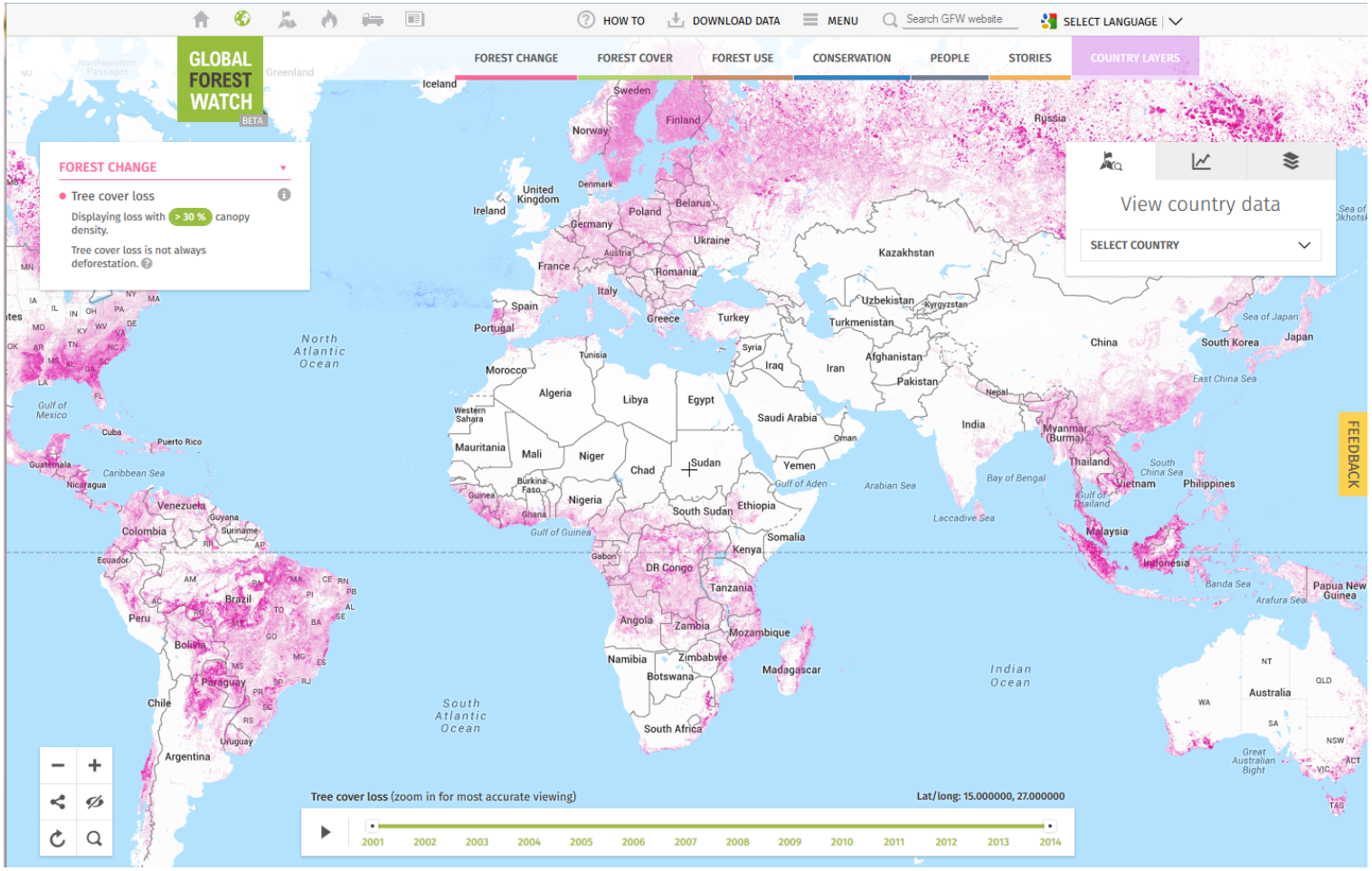

Data downloads

Web Viewers

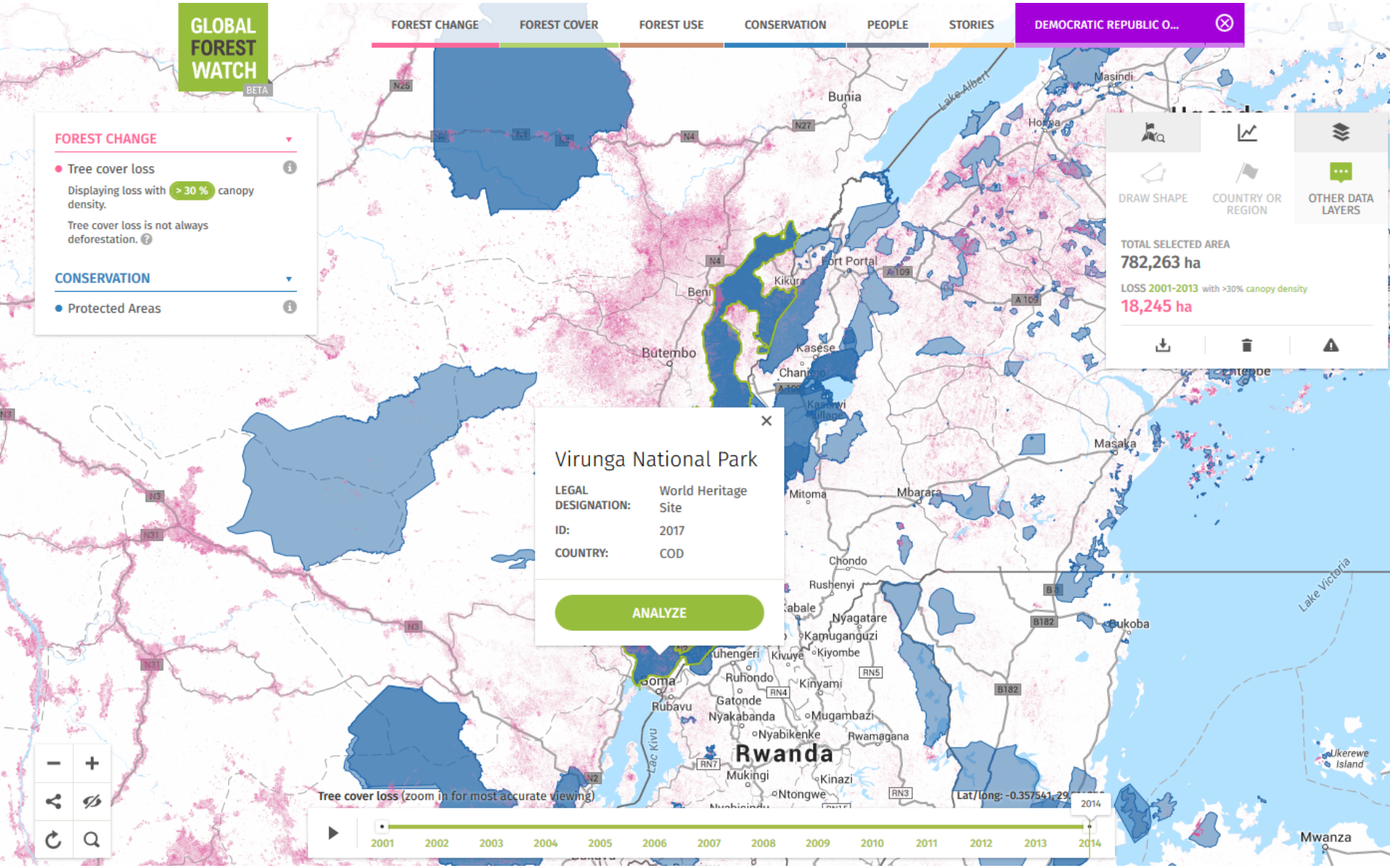
| Name | Dates | Image Source/ Location | Spatial Resolution | Available Data | Extent |
|---|---|---|---|---|---|
| National Land Cover Database 2011 (USGS) | 2001-2011 | Landsat TM | 30 m | Landcover, % impervious, % tree cover, landcover change | Conterminous U.S. |
| North American Landscape Characterization (USGS) | 1973,1986,1991 triplicates | Landsat MSS | | MSS images | Conterminous U.S. and Mexico |
| Vegetative Cover Conversion | 2000-2010 | MODIS (MOD44B) | 250 m | Percent tree cover | Global |
| Land Cover/Land Cover Change | 2001-2012 | MODIS (MCD12Q1) | 500 m | Land cover type | Global |
| Land Cover Dynamics | 2001-2010 | MODIS EVI (MCD12Q2) | 500m | Timing of vegetation phenology | Global |
| Forest Change Assessment Viewer | 2000-2013 | MODIS | 500 m | Forest change, phenology | U.S. |
| Global Forest Change (University of Maryland) | 2000-2012 | Landsat ETM+ | 30 m | Forest extent, loss and gain | Global |
| Global Forest Watch (World Resources Institute) | 2000-2012 | Landsat ETM+ | 30 m | Forest extent, loss and gain plus forest use, protected areas, etc. | Global |
| Worldview | Varies | Varies | varies | Fires, land surface temperature, snow cover | Global |

# Global Forest Watch Web Portal

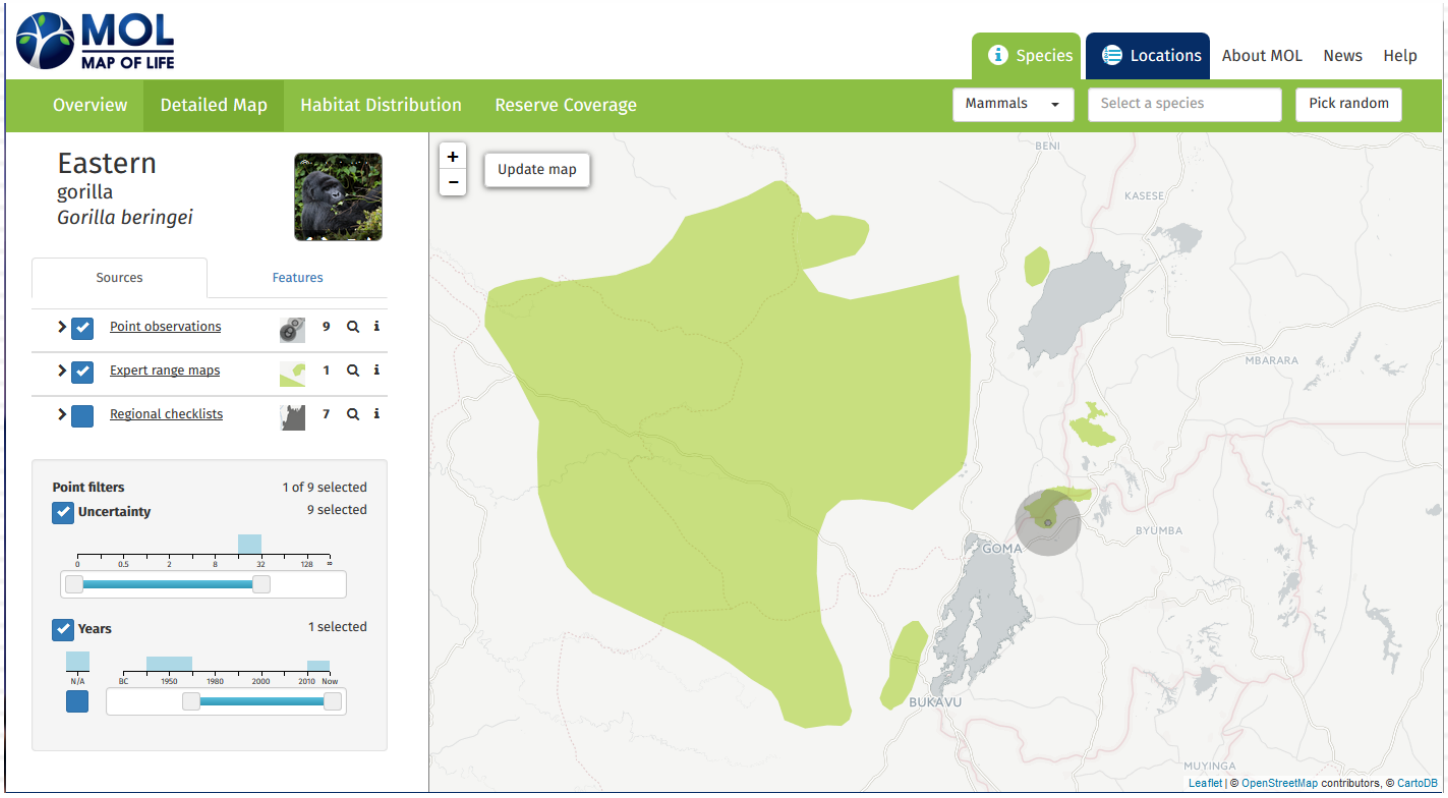
http://globalforestwatch.org



# Global Forest Watch Web Portal



# Live Demo: Map of Life



# Coming up next week!

**Week 4: Using remote sensing for monitoring animal movement**

# Important Information

- One lecture per week – every Tuesday May 5 to June 2
  - 12:00 – 1:00 PM EDT (Session 1)
  - 10:00 – 11:00 PM EDT (Session 2)

- Webinar recordings, PowerPoint presentations, and homework assignments can be found after each session at: https://arset.gsfc.nasa.gov/ecoforecasting/webinars/introduction-remote-sensing-conservation-management

- Certificate of Completion
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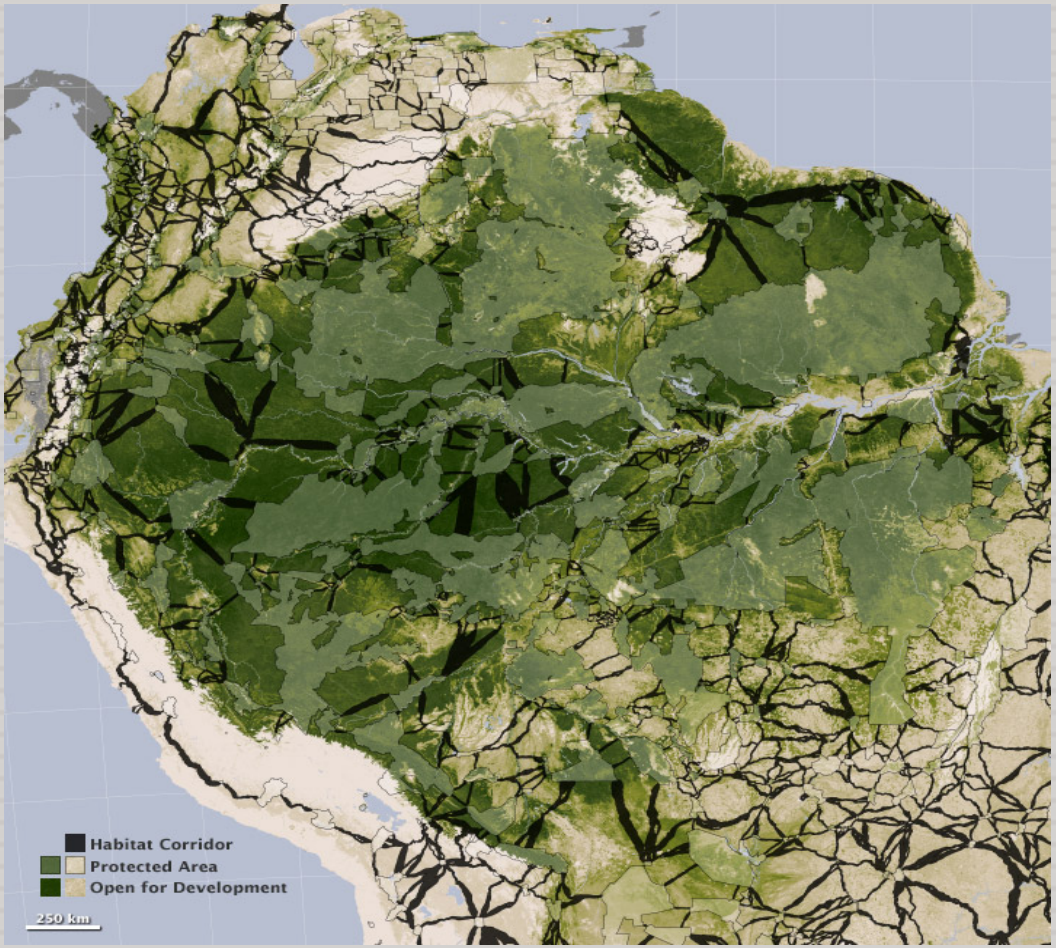
- Q/A: 15 minutes following each lecture and/or by email (cynthia.l.schmidt@nasa.gov)

This map shows the Amazon forests of South America.

Black lines show carbon-rich corridors. Light green shows protected areas. Dark green shows unprotected areas




Credit: Image by Robert Simmon, using data from Patrick Jantz and Alessandro Baccini

# Thank You!!

Cindy Schmidt

Cynthia.L.Schmidt@nasa.gov